

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re Application of:

Toru TSUKADA, et al.

Application No.: 09/809,262

Filed: March 16, 2001

For: FEED SCREW DEVICE

Assistant Commissioner for Patents
Washington, DC 20231

Sir:

VERIFICATION OF A TRANSLATION

I, the below named translator, hereby declare that:

My name and post office address are as stated below:

That I am knowledgeable in the English language and in the Japanese language
and believe the attached English translation to be a true and complete translation of the
certified copy of Japanese Patent Application No. Hei. 8-189148 filed in the U.S. Patent
and Trademark Office on July 18, 1996.

I hereby declare that all statements made herein of my own knowledge are true
and that all statements made on information and belief are believed to be true; and
further that these statements were made with the knowledge that willful false

Best Available Copy

statements and the like so made are punishable by fine or imprisonment, or both, and that such willful false statements may jeopardize the validity of the application or any patent issued thereon.

Full name of the translator: Kumiko Kawai

Post Office Address: Ark Mori Bldg., 28F, 12-32, Akasaka 1-chome, Minato-ku,
Tokyo 107-6028, Japan

Signature of the translator: 

Date: May 16, 2003

日 本 国 特 許 庁
PATENT OFFICE
JAPANESE GOVERNMENT

別紙添付の書類に記載されている事項は下記の出願書類に記載されて
る事項と同一であることを証明する。

This is to certify that the annexed is a true copy of the following application as filed
in this Office.

出 願 年 月 日
Date of Application:

1996年 7月18日

出 願 番 号
Application Number:

平成 8年特許願第189148号

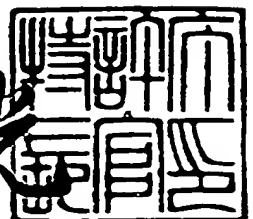
出 願 人
Applicant(s):

日本精工株式会社

1997年 8月 1日

特 許 庁 長 官
Commissioner,
Patent Office

荒井 寿光



出証番号 出証特平09-3058925

P.Hei.08-189148

[Document]	Patent Application
[Reference No.]	296056
[Application Date]	July 18, 1996
[Addressed To]	Commissioner, Patent Office
[International Patent Classification]	F16H 25/08
[Title of Invention]	Feed Screw Device
[Number of Claims]	1
[Inventor]	
[Address]	c/o NSK, Ltd., 78, Toriba-machi, Maebashi-shi, Gunma, Japan
[Name]	Sohichiro KATOH
[Applicant for Patent]	
[Identification No.]	000004204
[Appellation]	NSK, Ltd.
[Representative]	Tetsuo SEKIYA
[Agent]	
[Identification No.]	100066980
[Patent Attorney]	
[Name]	Tetsuya MORI
[Assigned Agent]	
[Identification No.]	100075579
[Patent Attorney]	
[Name]	Yoshiaki NAITOH
[Assigned Agent]	
[Identification No.]	100103850
[Patent Attorney]	
[Name]	Shutetsu SAI
[Indication of Fee]	

[Deposit Account No.] 001638

[Amount] ¥21,000

[List of Attached Documents]

[Article] Specification 1 copy

[Article] Drawings 1 copy

[Article] Abstract of the Description 1 copy

[No. of General Power of Attorney] 9006534

[No. of General Power of Attorney] 9402192

[Confirmed Specification] Required



[Name of Document]

Specification

[Title of Invention]

FEED SCREW DEVICE

[Claims]

[Claim 1] A feed screw device comprising a screw axis, a screw nut threadably engaging an outer periphery of the screw axis, and a sealing member being disposed at both ends of the screw nut for sealing the gap opening between the screw nut and the screw axis, the improvement wherein the sealing member is made of a lubricant-containing polymer member, the lubricant-containing polymer member being formed with lubricant pool parts.

[Detailed Description of the Invention]

【0001】

[Technical Field to which the Invention Belongs]

This invention relates to a feed screw device of a ball screw, square thread, etc. Particularly, this invention relates to a feed screw device that can automatically supply a lubricant over a long term.

【0002】

[Prior Art]

Known as a ball screw, a kind of conventional feed screw device, is a device wherein a space 4 between a screw axis 1 and a ball screw nut 2 threadably engaged into the screw axis 1 via a large number of balls 3 is filled with grease or lubricant oil, as shown in Figure 22. The ball screw is

of seal type wherein an annular recess 5 is made in an end of the ball screw nut 2 and a sealing member 6 is fitted into the annular recess 5 to prevent powder dust, etc., from entering the ball screw nut 2.

【0003】

By the way, to lubricate such a conventional ball screw device, normally grease or lubricant is supplied from a grease nipple 7 attached to the ball screw nut 2 to a ball circulation passage for lubricating a rolling element.

【0004】

However, particularly when the ball screw device adopting such a lubrication system directly using lubricant or grease is used in a high-temperature environment or in wood chips, the filled lubricant or grease flows out to the outside, is exhausted fast, and must be again supplied repeatedly for a short term. This applicant filed the application relating to an oil-containing polymer lubrication ball screw to improve the point (Japanese Utility Model Application No. Hei. 5-033341).

【0005】

For the oil-containing polymer lubrication ball screw, a sealing member mounted on a ball screw nut is formed of lubricant-containing rubber or synthetic resin and the lubricant continuously exuding from the sealing member is automatically supplied to a rolling element lubrication passage of the ball screw nut.

【0006】

[Problems that the Invention is to Solve]

However, with the ball screw, as the sealing member containing the lubricant runs with the ball screw nut while coming in contact with the screw axis, the lubricant exudes from the contact part for lubrication; lubricant supplied to a guide rail is easily absorbed particularly in an environment wherein foreign materials such as wood chips easily absorbing oil components, and the lubricant can also be absorbed from the lubricant-containing polymer member; resultantly, it is feared that a lubrication failure may be invited.

【0007】

It is therefore an object of the invention to provide a long-life feed screw device stable over a long term by automatically replenishing a sealing member with a lubricant for suppressing occurrence of a lubrication failure.

【0008】

[Means for Solving the Problems]

To the end, according to the invention, there is provided, in a feed screw device comprising a screw axis, a screw nut threadably engaging an outer periphery of the screw axis, and a sealing member being disposed at both ends of the screw nut for sealing the gap opening between the screw nut and the screw axis, the improvement wherein the sealing member is made of a lubricant-containing polymer member, the

lubricant-containing polymer member being formed with lubricant pool parts.

【0009】

According to invention, the lubricant-containing polymer member seals both the ends of the screw nut and shuts off the inside of the screw nut from the external atmosphere, whereby even in a bad environment of wood chips, etc., easily absorbing water and oil components in the external atmosphere, the inside of the screw nut is protected against the water, wood chips, etc., and the smooth lubrication effect can be maintained over a long time.

【0010】

As a lubricant exudes from the lubricant-containing polymer member and is consumed, the lubricant-containing polymer member is replenished with a new lubricant sealed in the lubricant pool parts, whereby the lubricant exudes from the lubricant-containing polymer member over a long time even in atmosphere wherein wood chips, etc., easily absorb the lubricant supplied to a guide rail, so that stable lubrication can be carried out for a long time.

【0011】

If foreign materials such as wood chips are deposited on the lubricant-containing polymer member and the lubricant is absorbed from the portion, the lubricant-containing polymer member is replenished with a lubricant from the lubricant pool

parts, thus it is not feared that a lubrication failure will be invited.

【0012】

For example, the product manufactured in the following manner can be used as the lubricant-containing polymer member:

Any of paraffin family hydrocarbon oil such as poly α -olefin oil, naphthene family hydrocarbon oil, mineral oil, ether oil such as dialkyl diphenyl ether oil, or ester oil such as phthalate ester or trimellitate ester is mixed as a lubricant with a polymer selected from the group consisting of polyolefin family polymers basically having the same chemical structure such as polyethylene, polypropylene, polybutylene, and polymethylpentane and the mixture is fused, then poured into a predetermined mold and cooled and fixed under pressure. Various additive agents such as an antioxidant, a rust preventive, a wear inhibitor, a defoaming agent, and an extreme pressure agent may be previously added to the mixture.

【0013】

Specifically, the lubricant pool parts formed in the sealing member may be lubricant pool holes made near the sealed face of the screw axis or a lubricant pool peripheral groove extending surrounding the screw axis. If an annular recess is made in the screw nut and the sealing member is fitted into the annular recess and the lubricant pool holes or the lubricant pool peripheral groove is closed on the inner peripheral surface

or bottom face of the recess, a lubricant filled in the lubricant pool holes or the lubricant pool peripheral groove can be sealed by a simple structure.

【0.0 1 4】

If the lubricant pool peripheral groove is formed, the lubricant-containing polymer member is replenished uniformly with a new lubricant sealed in the lubricant pool peripheral groove, thus stable lubrication can be carried out for a long time. If a plurality of the lubricant pool holes are made in the circumferential direction surrounding the screw axis, the lubricant-containing polymer member is replenished uniformly with a new lubricant in the lubricant pool holes, thus stable lubrication can be carried out for a long time.

【0.0 1 5】

If a reinforcing plate is disposed overlapping the lubricant-containing polymer member so as to shut off the lubricant-containing polymer member from the external atmosphere, it prevents wood chips, dust, etc., from coming in contact with the lubricant-containing polymer member, so that absorbing the lubricant in wood chips, dust, etc., from the portion can be prevented. If a reinforcing plate is disposed so that a compression force acts on the lubricant-containing polymer member, the lubricant-containing polymer member can be adjusted in hardness and insufficient strength by the reinforcing plate, and breakage, cracks, etc., of the

lubricant-containing polymer member can be prevented. Since the reinforcing plate is provided, a metal reinforcing plate (mandrel) need not be used; a problem of adhesion between the lubricant-containing polymer member containing a large amount of lubricant and the metal reinforcing plate need not be considered.

【0016】

When an annular recess is made in the screw nut and the lubricant-containing polymer member is fitted into the recess, if a garter spring is inserted between the inner peripheral surface of the recess and the outer periphery of the lubricant-containing polymer member, the garter spring presses the lubricant-containing polymer member in the radial direction of the screw axis at given pressure. Thus, if the face of the lubricant-containing polymer member coming in contact with the screw axis is worn because of long-term running, proper contact with the screw axis can always be provided and stable lubrication can be carried out.

【0017】

Further, if the lubricant-containing polymer member is formed with communication holes from the lubricant pool parts (lubricant pool holes, lubricant pool peripheral groove) to the face coming in contact with the screw axis, the lubricant sealed in the lubricant pool parts flows out into the screw axis through the communication holes. Thus, an appropriate

lubricant-containing polymer member is provided for a device requiring a large amount of lubricant.

【0018】

[Embodiments]

Referring now to the accompanying drawings, there are shown feed screw device of the invention. Members identical with or similar to those previously described in the prior art are denoted by the same reference numerals will not be discussed again.

【0019】

Figure 1 is a sectional view to show the main part of a ball screw device according to the first embodiment of the invention to show a specific structure of a feed screw device; the embodiment is applied particularly to a seal-type ball screw.

【0020】

In the embodiment, a spiral thread groove 1b is formed in an outer peripheral surface 1a of a screw axis indicated by reference numeral 1 and a ball screw nut indicated by reference numeral 2 is formed in an inner peripheral surface 2a with a thread groove 2b corresponding to the thread groove 1b. The ball screw nut 2 is threadably engaged into the screw axis 1 with a large number of balls 3 disposed between the thread grooves 1b and 2b. Although not shown, a ball circulation section for guiding the balls 3 into the thread grooves 1b

and 2b and rolling and circulating the balls is formed in the thick barrel portion of the ball screw.

【0021】

The ball screw nut 2 is formed in an end face with an annular recess 5 into which a lubricant-containing polymer member 10 is fitted. The lubricant-containing polymer member 10 is an elastic member formed like a cylindrical shape and having a cut part 10a along the substantially axial direction, as shown in Figure 2, and contains a lubricant such as grease or mineral oil.

【0022】

For example, the product manufactured in the following manner can be used as the lubricant-containing polymer member 10: Any of paraffin family hydrocarbon oil such as poly α -olefin oil, naphthene family hydrocarbon oil, mineral oil, ether oil such as dialkyl diphenyl ether oil, or ester oil such as phthalate ester or trimellitate ester is mixed as a lubricant with a polymer selected from the group consisting of polyolefin family polymers basically having the same chemical structure such as polyethylene, polypropylene, polybutylene and polymethylpentane and the mixture is fused, then poured into a predetermined mold and cooled and fixed under pressure.

Various additive agents such as an antioxidant, a rust preventive, a wear inhibitor, a defoaming agent, and an extreme pressure agent may be previously added to the mixture.

【0023】

The lubricant-containing polymer member 10 formed like a cylindrical shape is formed on an inner peripheral surface with a projection stripe 10b fitted into the thread groove 1b of the screw axis 1 and formed in one end face 10c with a plurality of lubricant pool holes 10d at positions distant from each other in the circumferential direction.

【0024】

The lubricant pool holes 10d are filled with a lubricant, an outer peripheral surface 10e of the lubricant-containing polymer member 10 is abutted against an inner peripheral surface 5a of the recess 5 made in an end face of the ball screw nut 2 and one end face 10c of the lubricant-containing polymer member 10 is abutted against a bottom face 5b of the recess 5. In this state, the projection stripe 10b is fitted into the thread groove 1b of the screw axis 1 whereby the lubricant-containing polymer member 10 is fitted into the recess 5 as shown in Figure 1. The ball screw nut 2 is formed with a tapped hole extending diametrically inward from the outer peripheral surface and opened at the recess 5. As shown in Figure 1, a set screw 11 is screwed into the tapped hole from the outer peripheral surface side, whereby the lubricant-containing polymer member 10 is fixed to the ball screw nut 2.

【0025】

Since the openings of the lubricant pool holes 10d are closed on the bottom face 5b of the recess 5 the lubricant in the lubricant pool holes 10d is sealed in the ball screw nut 2. The lubricant pool holes 10d correspond to lubricant pool parts of the invention.

【0026】

According to the ball screw device of the structure, when the screw axis 1 makes relative rotation to the ball screw nut 2 the balls 3 in the ball screw nut 2 roll on a spiral space formed by the relative thread grooves 1a and 2a in the rotation direction of the screw axis 1 and circulate through a ball circulation passage (not shown). As the balls 3 roll, the ball screw nut 2 is fed in the linear direction along the screw axis 1. When the ball screw nut 2 and the screw axis 1 make relative rotation, a lubricant exudes from the lubricant-containing polymer member 10 fitted into the recess 5 is supplied to the thread groove 1b of the screw axis 1 and uniformly covers the balls 3 rolling in the thread groove 1b and the thread groove 2b of the ball screw nut for stable lubrication. Therefore, if a lubricant is not supplied to the ball screw nut 2 from the outside, the ball screw can continue good running at low torque.

【0027】

The lubricant-containing polymer member 10 also functions as a sealing member for sealing the end of the ball

screw nut 2 and shuts off the inside of the ball screw nut 2 from the external atmosphere. Thus, even in a bad environment of wood chips, etc., easily absorbing water and oil components in the external atmosphere, the inside of the ball screw nut 2 is protected against the water, wood chips, etc., and the smooth lubrication effect can be maintained over a long time.

【0028】

As a lubricant exudes from the lubricant-containing polymer member 10 and is consumed, the lubricant-containing polymer member 10 is replenished with the lubricant sealed in the lubricant pool holes 10d, whereby the simple structure enables the lubricant to be sealed in the lubricant-containing polymer member 10 and the lubricant exudes from the lubricant-containing polymer member 10 over a long time. Thus, the balls 3 rolling in the thread groove 1b and the thread groove 2b of the ball screw nut can be stably lubricated for a long time.

【0029】

If foreign materials such as wood chips are deposited on the lubricant-containing polymer member 10 and absorb the lubricant, the lubricant-containing polymer member 10 is replenished with a lubricant from the lubricant pool holes 10d, thus it is not feared that a lubrication failure will be invited.

【0030】

Figure 3 shows a modified example of the lubricant-containing polymer member 10 of the first embodiment shown in Figure 2.

A modified example lubricant-containing polymer member 14 is also an elastic member formed like a cylindrical shape and having a cut part 14a along the substantially axial direction, and contains a lubricant such as grease or mineral oil by a molding method similar to that of the lubricant-containing polymer member 10.

【0031】

The lubricant-containing polymer member 14 is formed on an inner peripheral surface with a projection stripe 14b fitted into the thread groove 1b of the screw axis 1 and formed in one end face 14c with a lubricant pool peripheral groove 14d continuous in the circumferential direction:

【0032】

The lubricant pool peripheral groove 14d is filled with a lubricant, an outer peripheral surface 14e of the lubricant-containing polymer member 14 is abutted against an inner peripheral surface 5a of the recess 5 made in an end face of the ball screw nut 2 and one end face 14c of the lubricant-containing polymer member 14 is abutted against a bottom face 5b of the recess 5. In this state, the projection stripe 14b is fitted into the thread groove 1b of the screw axis 1 whereby the lubricant-containing polymer member 14 is

fitted into the recess 5. The lubricant-containing polymer member 14 is fixed to the ball screw nut 2 by the set screw 11 shown in Figure 1.

[0033]

Since the groove opening of the lubricant pool peripheral groove 14d made in the one end face 14c is closed on the bottom face 5b of the recess 5 the lubricant in the lubricant pool peripheral groove 14d is sealed in the ball screw nut 2. The lubricant pool peripheral groove 14d correspond to a lubricant pool part of the invention.

[0034]

The lubricant-containing polymer member 14 also functions as a sealing member for sealing the end of the ball screw nut 2 and shuts off the inside of the ball screw nut 2 from the external atmosphere. Thus, even in a bad environment of wood chips, etc., easily absorbing water and oil components in the external atmosphere, the inside of the ball screw nut 2 is protected against the water, wood chips, etc., and the smooth lubrication effect can be maintained over a long time.

[0035]

As a lubricant exudes from the lubricant-containing polymer member 14 and is consumed, the lubricant-containing polymer member 14 is replenished with the lubricant sealed in the lubricant pool peripheral groove 14d, whereby the lubricant exudes from the lubricant-containing polymer member

14 over a long time. Thus, the balls 3 rolling in the thread groove 1b and the thread groove 2b of the ball screw nut can be stably lubricated for a long time.

【0036】

If foreign materials such as wood chips are deposited on the lubricant-containing polymer member 14 and absorb the lubricant, the lubricant-containing polymer member 14 is replenished with a lubricant from the lubricant pool peripheral groove 14d, thus it is not feared that a lubrication failure will be invited.

【0037】

Figures 4 and 5 are sectional views to show the main part of a ball screw according to a second embodiment of the invention. Components identical with those previously described with reference to Figures 1 to 3 in the first embodiment are denoted by the same reference numerals and will not be discussed again.

【0038】

In the embodiment, a lubricant-containing polymer member 16 fitted into an annular recess 5 is an elastic member formed like a cylindrical shape and having a cut part 16a along the substantially axial direction, as shown in Figure 5, and contains a lubricant such as grease or mineral oil as in the first embodiment. The lubricant-containing polymer member 16 is formed on an inner peripheral surface with a projection

stripe 16b fitted into a thread groove 1b of a screw axis 1 and formed in an outer peripheral surface 16e with a plurality of lubricant pool holes 16d at positions distant from each other in the circumferential direction.

【0039】

The lubricant pool holes 16d are filled with a lubricant, the outer peripheral surface 16e of the lubricant-containing polymer member 16 is abutted against an inner peripheral surface 5a of the recess 5 made in a ball screw nut 2 and one end face 16c of the lubricant-containing polymer member 16 is abutted against a bottom face 5b of the recess 5. In this state, the projection stripe 16b is fitted into the thread groove 1b of the screw axis 1 whereby the lubricant-containing polymer member 16 is fitted into the recess 5 as shown in Figure 4. Set screws 11 are screwed into tapped holes made toward the recess 5 of the ball screw nut 2 whereby the tips of the set screws 11 are engaged into the lubricant pool holes 16d for fixing the lubricant-containing polymer member 16 to the ball screw nut 2.

【0040】

Since the openings of the lubricant pool holes 16d are closed on the inner peripheral surface 5a of the recess 5 the lubricant in the lubricant pool holes 16d is sealed in the ball screw nut 2. The lubricant pool holes 16d correspond to lubricant pool parts of the invention.

【0041】

According to the ball screw device of the structure, when the screw axis 1 makes relative rotation to the ball screw nut 2 the balls 3 in the ball screw nut 2 roll on a spiral space formed by the relative thread grooves 1a and 2a in the rotation direction of the screw axis 1 and circulate through a ball circulation passage (not shown). As the balls 3 roll, the ball screw nut 2 is fed in the linear direction along the screw axis 1. When the ball screw nut 2 rotates, a lubricant exudes from the lubricant-containing polymer member 16 fitted into the recess 5 is supplied to the thread groove 1b of the screw axis 1 and uniformly covers the balls 3 rolling in the thread groove 1b and the thread groove 2b of the ball screw nut for stable lubrication. Therefore, if a lubricant is not supplied to the ball screw nut 2 from the outside, the ball screw can continue good running at low torque.

【0042】

The lubricant-containing polymer 16 also functions as a sealing member for sealing the end of the ball screw nut 2 and shuts off the inside of the ball screw nut 2 from the external atmosphere. Thus, even in a bad environment of water, wood chips, etc., in the external atmosphere, the inside of the ball screw nut 2 is protected against the water, wood chips, etc., and the smooth lubrication effect can be maintained over a long time.

【0043】

As a lubricant exudes from the lubricant-containing polymer member 16 and is consumed, the lubricant-containing polymer member 16 is replenished with the lubricant sealed in the lubricant pool holes 16d, whereby the lubricant exudes from the lubricant-containing polymer member 16 over a long time. Thus, the balls 3 rolling in the thread groove 1b and the thread groove 2b of the ball screw nut can be stably lubricated for a long time.

【0044】

If foreign materials such as wood chips are deposited on the lubricant-containing polymer member 16 and absorb the lubricant, the lubricant-containing polymer member 16 is replenished with a lubricant from the lubricant pool holes 16d, thus it is not feared that a lubrication failure will be invited.

【0045】

Figure 6 shows a modified example of the lubricant-containing polymer member 16 of the second embodiment shown in Figure 5.

A modified example lubricant-containing polymer member 18 is also an elastic member formed like a cylindrical shape and having a cut part 18a along the substantially axial direction, and contains a lubricant such as grease or mineral oil by a molding method similar to that of the lubricant-containing

polymer member 16.

【0046】

The lubricant-containing polymer member 18 is formed on an inner peripheral surface with a projection stripe 18b fitted into the thread groove 1b of the screw axis 1 and formed in an outer peripheral surface 18e with a lubricant pool peripheral groove 18d continuous in the circumferential direction.

【0047】

The lubricant pool peripheral groove 18d is filled with a lubricant, an outer peripheral surface 18e of the lubricant-containing polymer member 18 is abutted against an inner peripheral surface 5a of the recess 5 made in the ball screw nut 2 and one end face 18c of the lubricant-containing polymer member 18 is abutted against a bottom face 5b of the recess 5. In this state, the projection stripe 18b is fitted into the thread groove 1b of the screw axis 1 whereby the lubricant-containing polymer member 18 is fitted into the recess 5. A set screw 11 is screwed into the lubricant pool peripheral groove 18d for fixing the lubricant-containing polymer member 18 to the ball screw nut 2.

【0048】

Since the groove opening of the lubricant pool peripheral groove 18d made in the outer peripheral surface 18e of the lubricant-containing polymer member 18 is closed on the inner

peripheral surface 5a of the recess 5 the lubricant in the lubricant pool peripheral groove 18d is sealed in the ball screw nut 2. The lubricant pool peripheral groove 18d correspond to a lubricant pool part of the invention.

【0049】

The lubricant-containing polymer member 18 also functions as a sealing member for sealing the end of the ball screw nut 2 and shuts off the inside of the ball screw nut 2 from the external atmosphere. Thus, even in a bad environment of wood chips, etc., easily absorbing water and oil components in the external atmosphere, the inside of the ball screw nut 2 is protected against the water, wood chips, etc., and the smooth lubrication effect can be maintained over a long time.

【0050】

As a lubricant exudes from the lubricant-containing polymer member 18 and is consumed, the lubricant-containing polymer member 18 is replenished with the lubricant sealed in the lubricant pool holes 18d, whereby the simple structure enables the lubricant to be sealed in the lubricant-containing polymer member 18 and the lubricant exudes from the lubricant-containing polymer member 14 over a long time. Thus, the balls 3 rolling in the thread groove 1b and the thread groove 2b of the ball screw nut can be stably lubricated for a long time.

【0051】

If foreign materials such as wood chips are deposited on the lubricant-containing polymer member 18 and absorb the lubricant, the lubricant-containing polymer member 18 is replenished with a lubricant from the lubricant pool holes 18d, thus it is not feared that a lubrication failure will be invited.

【0052】

Figure 7 is a sectional view to show the main part of a ball screw according to a third embodiment of the invention. Components identical with those previously described with reference in the first embodiment are denoted by the same reference numerals and will not be discussed again.

【0053】

In the embodiment, a lubricant-containing polymer member 20 is fitted into an annular recess 5. The lubricant-containing polymer member 20 has the same structure as the lubricant-containing polymer member 10 shown in Figure 2 except that it is formed with a plurality of lubricant pool holes 20d filled with a lubricant in the circumferential direction of an opposed end face 20f. The right opening of the lubricant-containing polymer member 20 (in Figure 7) is sealed by a reinforcing plate 22.

【0054】

The reinforcing plate 22 is a disk member made of a material of a steel plate, hard rubber, plastic plate, etc.,

and formed with an insertion hole 22a for a screw axis 1 at the position of the center of axle. It has an outer peripheral diameter set slightly smaller than the outer peripheral diameter of the end face of a ball screw nut 2 and the insertion hole 22a is set slightly larger than the outer diameter of the screw axis 1. While pressing the lubricant-containing polymer member 20 against a bottom face 5b of the recess 5 the reinforcing plate 22 is fixed to the ball screw nut 2 by set screws 24 indicated by alternate long and short dash lines in Figure 7.

[0055]

Since the openings of the lubricant pool holes 22d are closed on the reinforcing plate 22, the lubricant in the lubricant pool holes 22d is sealed in the reinforcing plate 22 integral with the ball screw nut 2. The lubricant pool holes 22d correspond to lubricant pool parts of the invention.

[0056]

According to the ball screw device with the above-mentioned structure, as well as the other embodiments, a lubricant exudes from the lubricant-containing polymer member 22 fitted into the recess 5 is supplied to the thread groove 1b of the screw axis 1 and uniformly covers the balls 3 rolling in the thread groove 1b and the thread groove 2b of the ball screw nut for stable lubrication. Therefore, if a lubricant is not supplied to the ball screw nut 2 from the outside, the

ball screw can continue good running at low torque.

【0057】

As a lubricant exudes from the lubricant-containing polymer member 22 and is consumed, the lubricant-containing polymer member 22 is replenished with the lubricant sealed in the lubricant pool holes 22d, whereby the simple structure enables the lubricant to be sealed in the lubricant-containing polymer member 22 and the lubricant exudes from the

lubricant-containing polymer member 22 over a long time. Thus, the balls 3 rolling in the thread groove 1b and the thread groove 2b of the ball screw nut can be stably lubricated for a long time.

【0058】

As the effect proper to the embodiment, the lubricant-containing polymer member 20 is shut off from the external atmosphere by the reinforcing plate 22, so that wood chips, dust, etc., can be prevented from entering the lubricant-containing polymer member 20; it is not feared that the lubricant is absorbed into wood chips, dust, etc., from the portion.

【0059】

Since the lubricant-containing polymer member 20 is held down by the reinforcing plate 22 from the opening of the recess 5 (right in Figure 7), an adhesion problem need not be considered. The lubricant-containing polymer member 20

can be adjusted in hardness and insufficient strength by press pressure received from the reinforcing plate 22, thus breakage, cracks, etc., can be prevented from occurring.

【0060】

Further, in the embodiment, if the lubricant sealed in the lubricant pool holes 22d becomes insufficient, the lubricant pool holes 22d can be easily replenished with a lubricant simply by loosening the set screws 24 and removing the reinforcing plate 22 from the ball screw nut 22.

【0061】

The embodiment uses the lubricant-containing polymer member 20 formed in the opposed end face 20f with a plurality of lubricant pool holes 20d. However, if a lubricant-containing polymer member 20 formed in the opposed end face 20f with a lubricant pool peripheral groove continuous in the circumferential direction (member similar to the lubricant-containing polymer member 14 shown in Figure 3) is used, the function and effects similar to those of the embodiment can be provided.

【0062】

Figure 8 is a sectional view to show the main part of a ball screw device according to a fourth embodiment of the invention.

In the embodiment, the lubricant-containing polymer member 16 formed in the outer peripheral surface 16e with a

plurality of lubricant pool holes 16d shown in Figure 5 is fitted into an annular recess 5 and the right opening of the lubricant-containing polymer member 16 (in Figure 8) is sealed by a reinforcing plate 22.

【0063】

According to the ball screw device with the above-mentioned structure, as well as the other embodiments, a lubricant exudes from the lubricant-containing polymer member 16 fitted into the recess 5 is supplied to the thread groove 1b of the screw axis 1 and uniformly covers the balls 3 rolling in the thread groove 1b and the thread groove 2b of the ball screw nut for stable lubrication. Therefore, if a lubricant is not supplied to the ball screw nut 2 from the outside, the ball screw can continue good running at low torque.

【0064】

As a lubricant exudes from the lubricant-containing polymer member 16 and is consumed, the lubricant-containing polymer member 16 is replenished with the lubricant sealed in the lubricant pool holes 16d, whereby the simple structure enables the lubricant to be sealed in the lubricant-containing polymer member 16 and the lubricant exudes from the lubricant-containing polymer member 16 over a long time. Thus, the balls 3 rolling in the thread groove 1b and the thread groove 2b of the ball screw nut can be stably lubricated for a long time.

【0065】

As the effect proper to the embodiment, the lubricant-containing polymer member 16 is shut off from the external atmosphere by the reinforcing plate 22, so that wood chips, dust, etc., can be prevented from entering the lubricant-containing polymer member 16; it is not feared that the lubricant is absorbed into wood chips, dust, etc., from the portion.

【0066】

Since the lubricant-containing polymer member 16 is held down by the reinforcing plate 22 from the opening of the recess 5 (right in Figure 8), an adhesion problem need not be considered. The lubricant-containing polymer member 16 can be adjusted in hardness and insufficient strength by pressure received from the reinforcing plate 22, thus breakage, cracks, etc., can be prevented from occurring.

【0067】

The embodiment uses the lubricant-containing polymer member 16 formed in the outer peripheral surface 16e with a plurality of lubricant pool holes 16d. However, if the lubricant-containing polymer member 18 shown in Figure 6, namely, member formed in the outer peripheral surface 18e with the lubricant pool peripheral groove 18d is used, the function and effects similar to those of the embodiment can be provided.

【0068】

Next, Figure 9 shows a fifth embodiment of the invention. Particularly, Figure 9 shows a modified example of the third embodiment in Figure 7.

That is, in this embodiment, the peripheral groove 20g is formed on the outer peripheral surface 20e of the lubricant-containing polymer member 20, and spring (garter spring) 26 is fitted into between the peripheral groove 20g and the inner peripheral surface 5a of the recess 5.

【0069】

The embodiment with the above-mentioned structure can obtain the same effect as the other embodiments. Further, since the screw 26 pushes the lubricant-containing polymer member 20 to the screw groove 1b of the screw axis 1 in the radial direction at a given pressure, even if a projection stripe 22b of the lubricant-containing polymer member 20 wears, the suitable contact with the screw axis 1 can be maintained, and a good lubricant property and seal property can be obtained.

【0070】

Lubricant-containing polymer members 28A, 28B, 29C as shown in Figures 10 to 12 are formed with the peripheral groove 28a, 28b, 28c on the peripheral surfaces 10e, 14e, 16e of the lubricant-containing polymer member 10, 14, 16 shown in Figures 2, 3, 5 for fitting the screw 26 into between the recess 5 and them.

【0071】

If the lubricant-containing polymer members 28A, 28B, 29C provided with the peripheral groove 28a, 28b, 28c is used as the lubricant-containing polymer member of the fifth embodiment, this embodiment can obtain the same effect as the fifth embodiment.

【0072】

Lubricant-containing polymer members 30A, 30B, and 30C shown in Figures 13 to 15 are modified examples of the lubricant-containing polymer members 10, 14, and 16 shown in Figures 2 and 3 to 5.

【0073】

The lubricant-containing polymer member 30A, 30B, 30C is formed with microscopic communication holes 30a, 30b, 30c for communicating lubricant pool holes 10d and a projection stripe 10b, a lubricant pool peripheral groove 14d and a projection stripe 14b, lubricant pool holes 16d and a projection stripe 16b. Slit-like or small-hole-like outflow openings 30a1, 30b1, 30c1 are made in the projection stripe 10b, 14b, 16b.

【0074】

With a ball screw using the lubricant-containing polymer member 30A of the structure, a lubricant sealed in the lubricant pool holes 10d flows out directly into the outflow opening 30a1 through the communication hole 30a. Thus, if much lubricant is required to provide stable lubrication, the

lubricant-containing polymer member 30A becomes an optimum member. With another lubricant-containing polymer member 30B (30C), a lubricant sealed in the lubricant pool peripheral groove 14d (lubricant pool holes 16d) flows out directly into the outflow opening 30b1 (30c1) through the communication hole 30b (30c). Thus, similar effects to those of the lubricant-containing polymer member 30A can be provided.

【0075】

Lubricant-containing polymer members 32A, 32B, and 32C shown in Figures 16 to 18 are modified examples of the lubricant-containing polymer members 28A, 28B, and 28C shown in Figures 10, 11 and 12.

【0076】

The lubricant-containing polymer member 32A, 32B, 32C is formed with microscopic communication holes 30a, 30b, 30c for communicating lubricant pool holes 10d and a projection stripe 10b, a lubricant pool peripheral groove 14d and a projection stripe 14b, lubricant pool holes 16d and a projection stripe 16b. Slit-like or small-hole-like outflow openings 30a1, 30b1, 30c1 are made in the projection stripe 10b, 14b, 16b.

【0077】

According to the ball screw device with the above-mentioned lubricant-containing polymer member 32A, since the screw 26 inserted between the peripheral groove 28a and

the inner peripheral surface 5a of the recess 5 pushes to the screw groove 1b of the screw axis 1 in the radial direction at a given pressure, the suitable contact with the screw axis 1 can be maintained, and a good lubricant property and seal property can be obtained. If the much lubricant needs to get the stable lubricant, it can be a most suitable lubricant-containing polymer member 32A. The other lubricant-containing polymer member 32B, 32C also can be same effect.

【0078】

Figure 19 shows a single axis actuator comprising the ball screw devices of the embodiments. The single axis actuator comprises a ball screw nut (not shown) in a slider 34 disposed for relative rotation via balls in a screw axis 1 having both ends supported for rotation. Reference numeral 36 is a ball circulation section for guiding a large number of balls into thread grooves of the screw axis 1 and the ball screw nut and circulating the balls. A lubricant-containing polymer member to which a reinforcing plate is attached, fixed by a set screw 38 is disposed at position A outside the ball circulation section 36. A lubricant-containing polymer member to which a reinforcing plate is attached is also disposed at position B facing position A with the slider 34 between.

【0079】

Figures 20 and 21 show the lubricant-containing polymer

member 40 used with the single axis actuator. The lubricant-containing polymer member 40 is formed with a lubricant pool peripheral groove 40a similar to that of the member, for example, shown in Figure 3 and lubricant pool holes 40b similar to those of the member, for example, shown in Figure 2 at positions distant from the lubricant pool peripheral groove 40a. The lubricant pool peripheral groove 40a and the lubricant pool holes 40b are filled with a lubricant. As the lubricant exudes from the lubricant-containing polymer member 40 and is consumed, the lubricant pool peripheral groove 40a and the lubricant pool holes 40b are replenished with a lubricant.

【0080】

If the lubricant-containing polymer member 40 comprises the lubricant pool peripheral groove 40a and the lubricant pool holes 40b as lubricant pool parts as described above, the invention can also produce the function and effects similar to those of the embodiments.

【0081】

In the embodiments, we have discussed the ball screw devices, but the invention is not limited to them; if the invention is applied to slide screw devices adopting angular screws, etc., similar function and effects can be provided.

【0082】

[Effect of the Invention]

As we have discussed, according to the feed screw device

of the invention, the lubricant-containing polymer member seals both the ends of the screw nut and shuts off the inside of the screw nut from the external atmosphere, so that even in a bad environment of wood chips, etc., easily absorbing water and oil components in the external atmosphere, the inside of the screw nut is protected against the water, wood chips, etc., and the smooth lubrication effect can be maintained over a long time.

【0083】

As a lubricant exudes from the lubricant-containing polymer member and is consumed, the lubricant-containing polymer member is replenished with a new lubricant sealed in the lubricant pool parts, thus the lubricant exudes from the lubricant-containing polymer member over a long time and stable lubrication can be carried out for a long time.

【0084】

Further, if foreign materials such as wood chips are deposited on the lubricant-containing polymer member and absorb the lubricant, the lubricant-containing polymer member is replenished with a lubricant from the lubricant pool parts, thus it is not feared that a lubrication failure will be invited.

[Brief Description of the Drawings]

[Fig. 1]

Figure 1 is a sectional view to show the main part of a ball screw device according to a first embodiment of the

invention;

[Fig. 2]

Figure 2 is a perspective view to show a lubricant-containing polymer member used in the first embodiment of the invention of Figure 1;

[Fig. 3]

Figure 3 is a perspective view to show a modified example of the lubricant-containing polymer member shown in Figure 2;

[Fig. 4]

Figure 4 is a sectional view to show the main part of a ball screw device according to a second embodiment of the invention;

[Fig. 5]

Figure 5 is a perspective view to show a lubricant-containing polymer member used in the second embodiment of the invention of Figure 4;

[Fig. 6]

Figure 6 is a perspective view to show a modified example of the lubricant-containing polymer member shown in Figure 5;

[Fig. 7]

Figure 7 is a sectional view to show the main part of a ball screw device according to a third embodiment of the invention;

[Fig. 8]

Figure 8 is a sectional view to show the main part of a ball screw device according to a fourth embodiment of the invention;

[Fig. 9]

Figure 9 is a sectional view to show the main part of a ball screw device according to a fifth embodiment of the invention;

[Fig. 10]

Figure 10 is a perspective view to show a lubricant-containing polymer member used in the fifth embodiment of the invention of Figure 9;

[Fig. 11]

Figure 11 is a perspective view to show a first modified example of the lubricant-containing polymer member shown in Figure 10;

[Fig. 12]

Figure 12 is a perspective view to show a second modified example of the lubricant-containing polymer member shown in Figure 10;

[Fig. 13]

Figure 13 is an illustration to show a first modified example of a lubricant-containing polymer member formed with communication holes according to the invention;

[Fig. 14]

Figure 14 is an illustration to show a second modified example of a lubricant-containing polymer member formed with communication holes according to the invention;

[Fig. 15]

Figure 15 is an illustration to show a third modified example of a lubricant-containing polymer member formed with communication holes according to the invention;

[Fig. 16]

Figure 16 is an illustration to show a fourth modified example of a lubricant-containing polymer member formed with communication holes according to the invention;

[Fig. 17]

Figure 17 is an illustration to show a fifth modified example of a lubricant-containing polymer member formed with communication holes according to the invention;

[Fig. 18]

Figure 18 is an illustration to show a sixth modified example of a lubricant-containing polymer member formed with communication holes according to the invention;

[Fig. 19]

Figure 19 is a perspective view to show application of the invention to a single axis actuator;

[Fig. 20]

Figure 20 is a front view to show a lubricant-containing polymer member used with the single axis actuator in Figure

19;

[Fig. 21]

Figure 21 is a sectional view taken on line C-C in Figure 20; and

[Fig. 22]

Figure 22 is a sectional view to show a conventional feed screw device.

[Description of Reference Numerals and Signs]

1 screw axis

1b screw groove

2 ball screw nut (screw nut)

2b screw groove

4 space between screw axis and ball screw nut

5 recess

10, 14, 16, 18, 20, 28A, 28B, 28C, 30A, 30B, 30C, 32A, 32B, 32C, 40

lubricant-containing polymer member (sealing member)

10d, 16d, 20d, 40b lubricant pool hole (lubricant pool part)

14d, 18d lubricant pool peripheral groove (lubricant pool part)

26 spring

30a, 30b, 30c communication hole

[Name of Document] Abstract of the Disclosure

[Abstract]

[Object] To provide a long-life feed screw device stable over a long term by automatically replenishing a sealing member with a lubricant for suppressing occurrence of a lubrication failure.

[Solving Means] A feed screw device comprises a screw axis 1, a screw nut 2 threadably engaging an outer periphery of the screw axis 1, and a sealing member being disposed at both ends of the screw nut 2 for sealing the gap opening between the screw nut 2 and the screw axis 1. The sealing member is made of a lubricant-containing polymer member 10. The lubricant-containing polymer member 10 is formed with lubricant pool holes 10d at a position near an outer peripheral surface 1a of the screw axis 1, the lubricant pool holes 10d being filled with a lubricant in a state they are surrounded with a recess 5 of the ball screw nut 2.

[Selected Drawing]

Fig. 1

1 screw axis

1b screw groove

2 ball screw nut

2b screw groove

3 ball

5 recess

10, 20, 16 lubricant-containing polymer member

10d, 16d lubricant pool hole

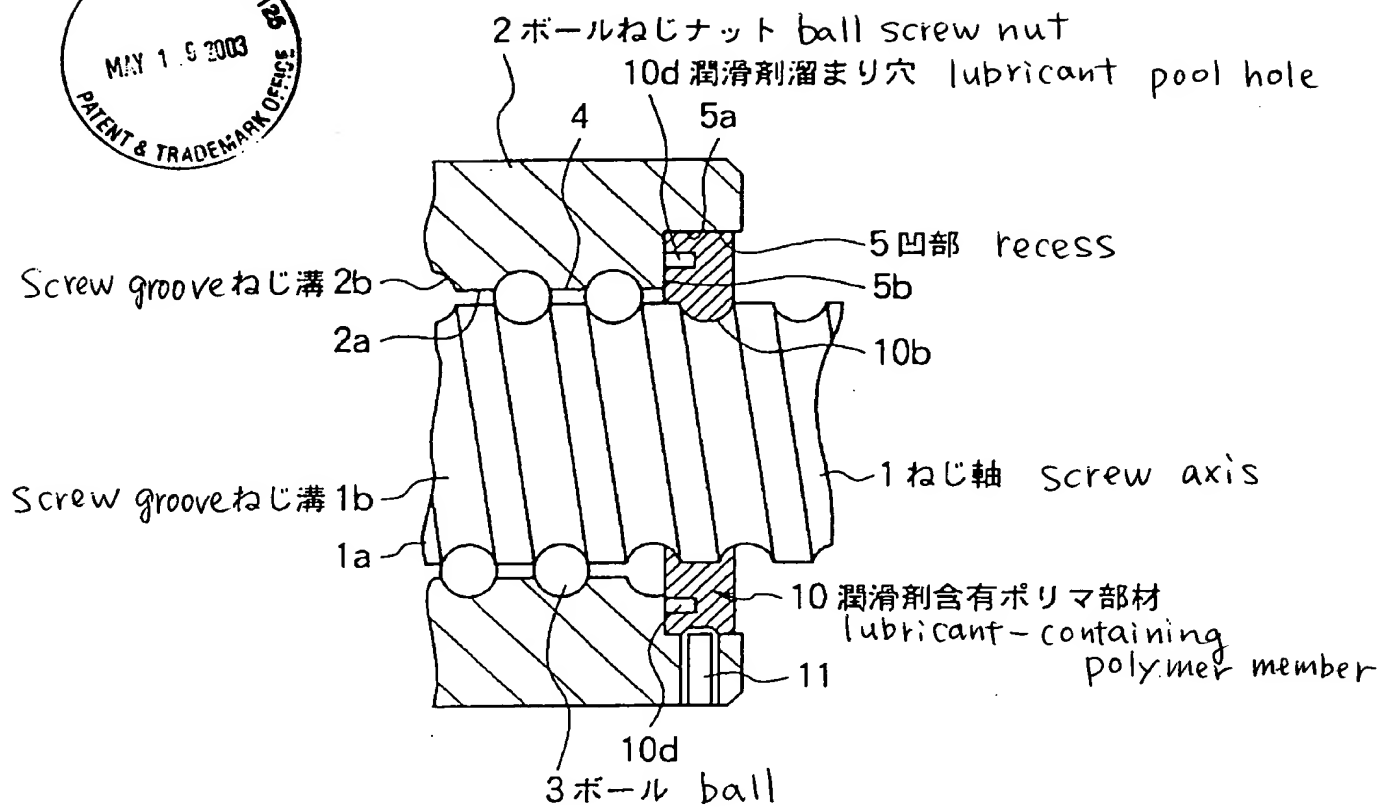
14d, 18d lubricant pool peripheral groove

22 reinforcing plate

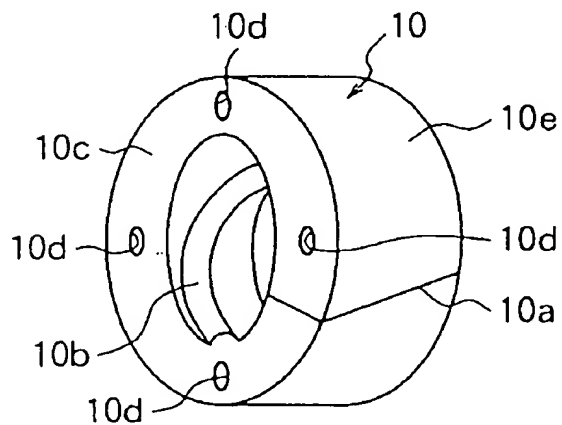
26 spring (gaster spring)

【書類名】 図面 Drawing

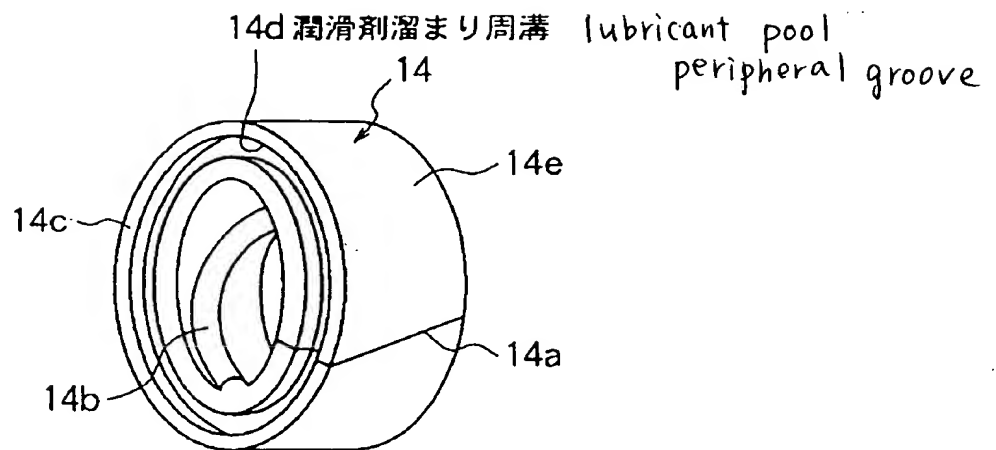
【図1】 Fig 1



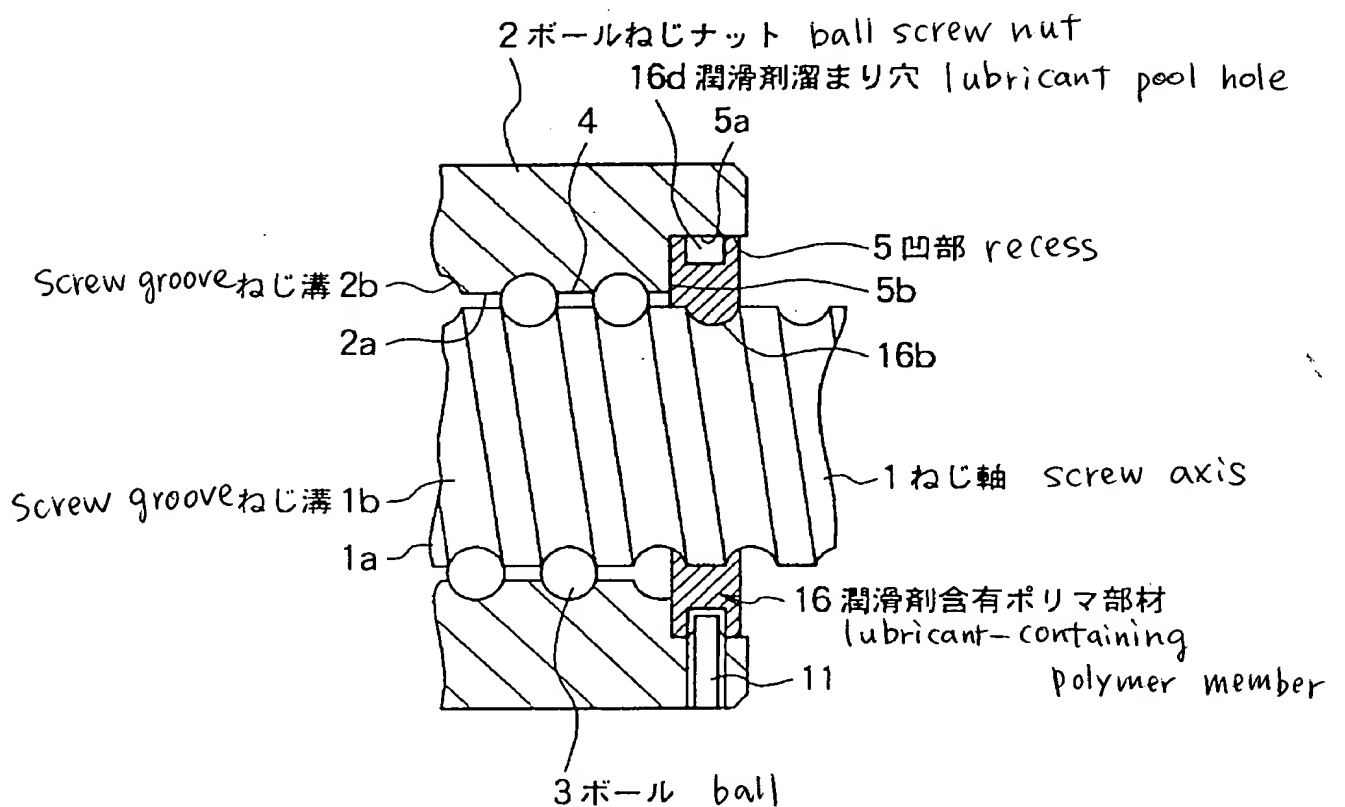
【図2】 Fig 2



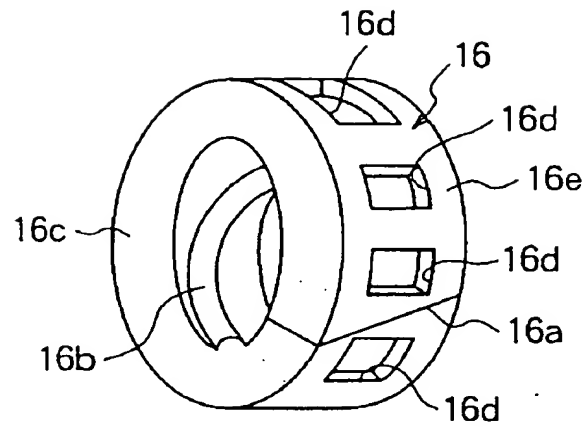
【図3】 Fig 3



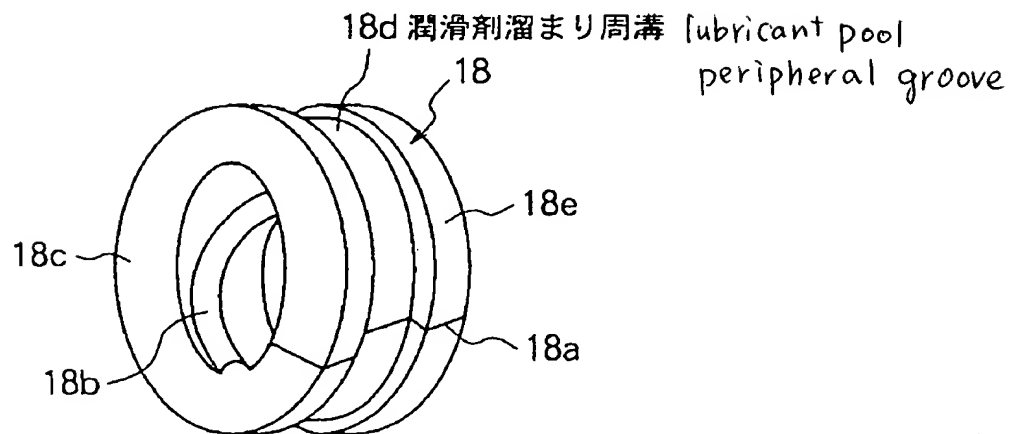
【図4】 Fig 4



【図5】 Fig 5

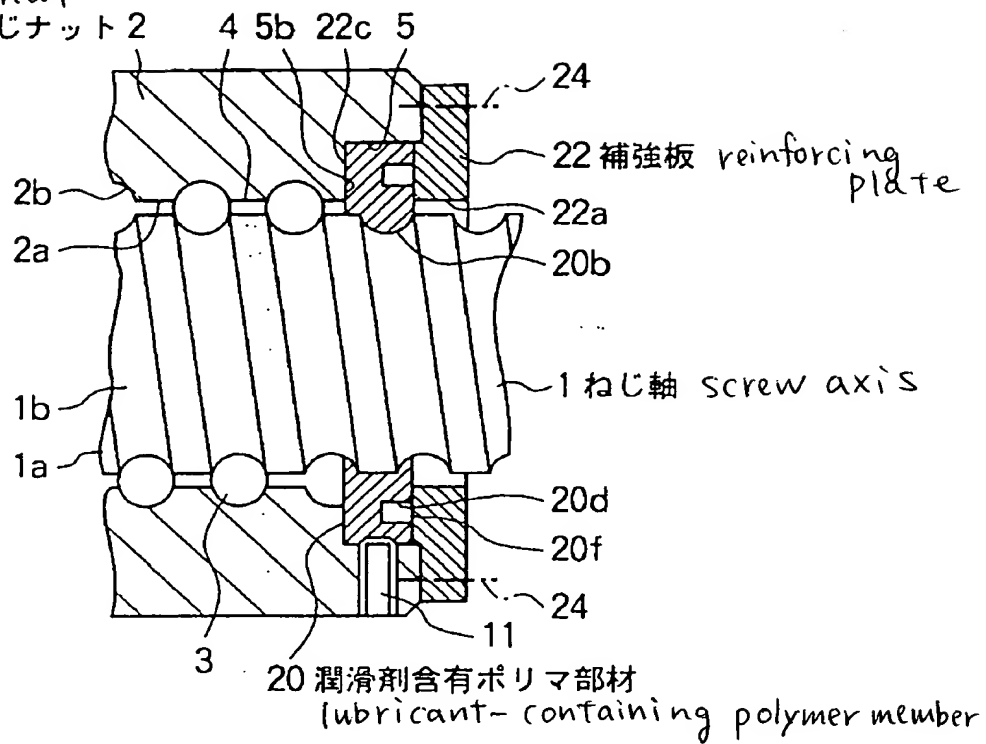


【図6】 Fig 6



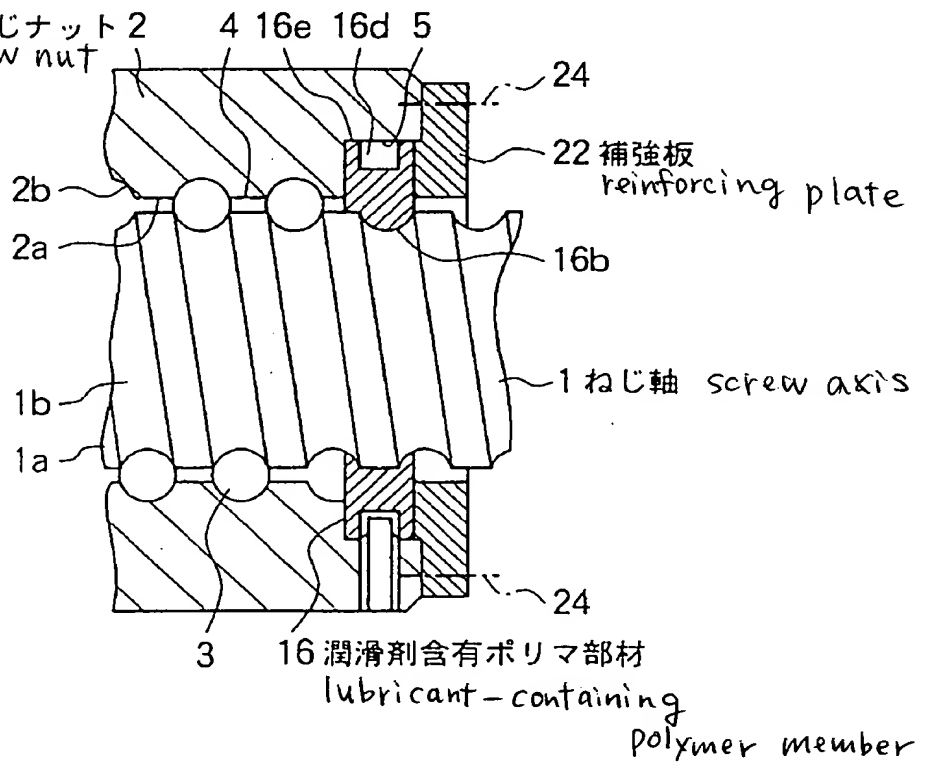
【図7】 Fig 7

ball screw nut
ボールねじナット 2

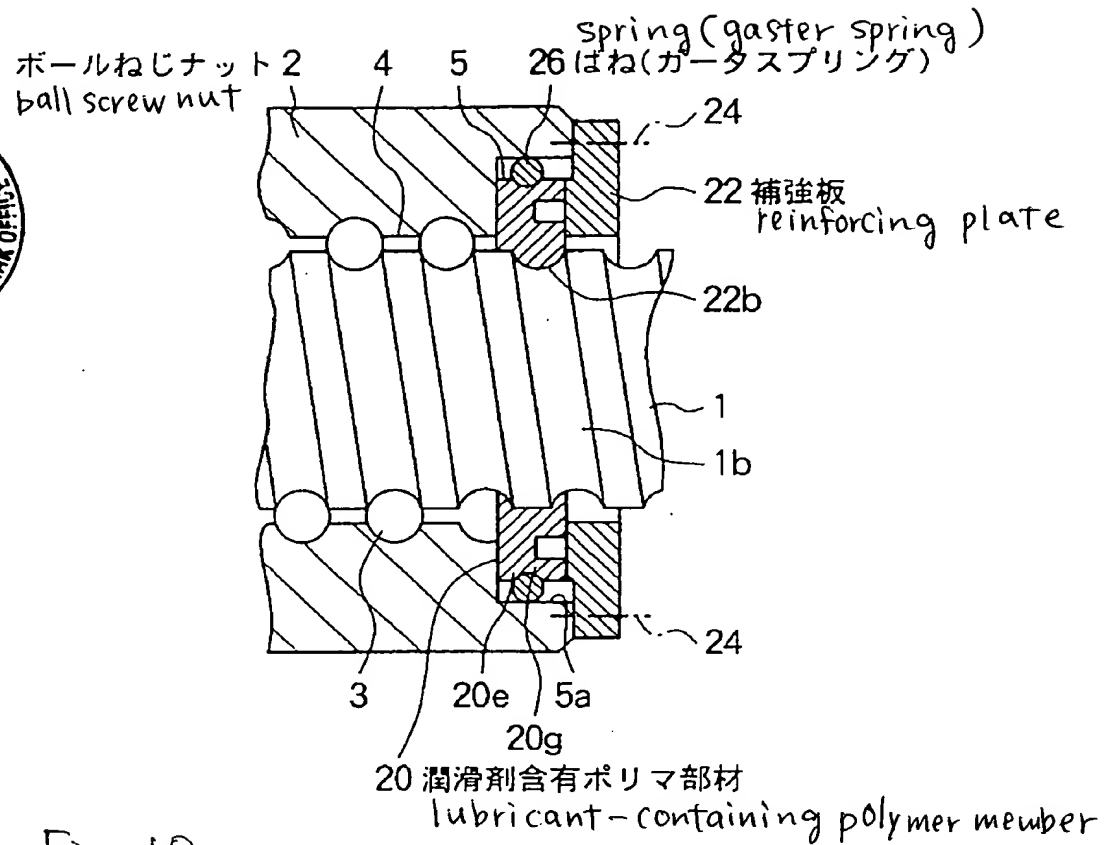


【図8】 Fig 8

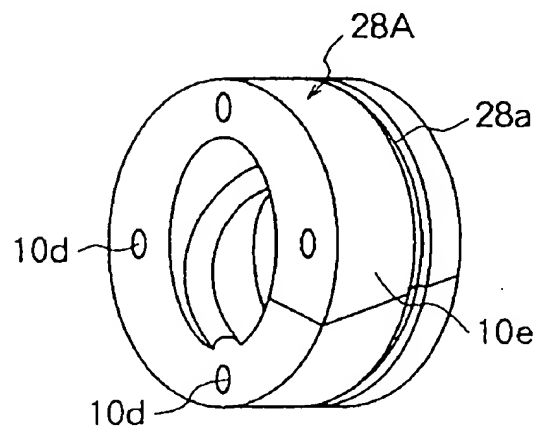
ボールねじナット 2
ball screw nut



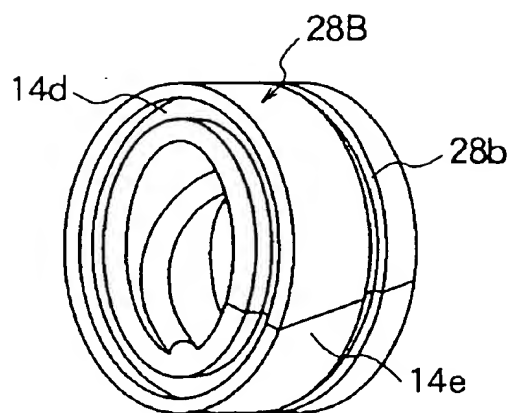
【図9】 Fig 9



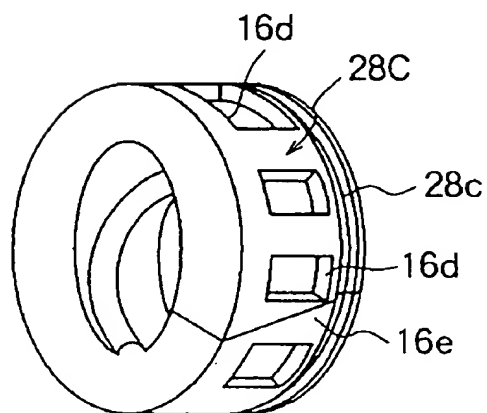
【図10】 Fig 10



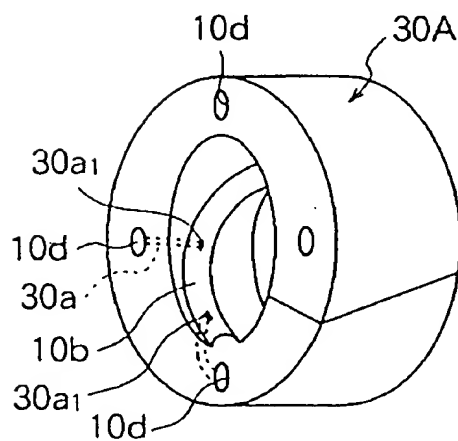
【図11】 Fig 11



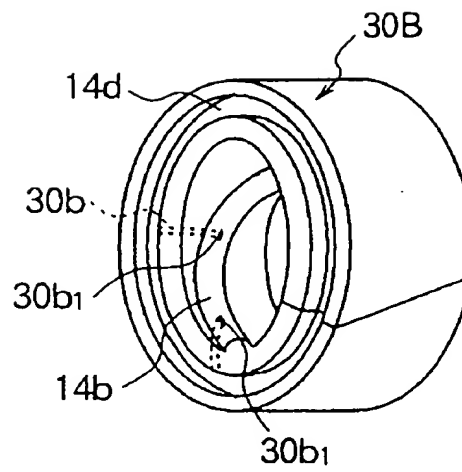
【図12】 Fig 12



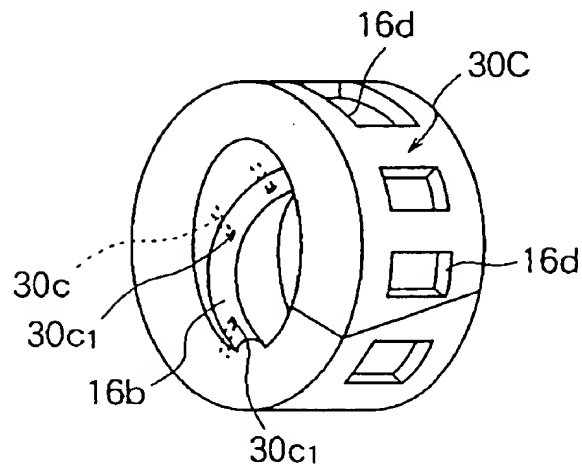
【図13】 Fig 13



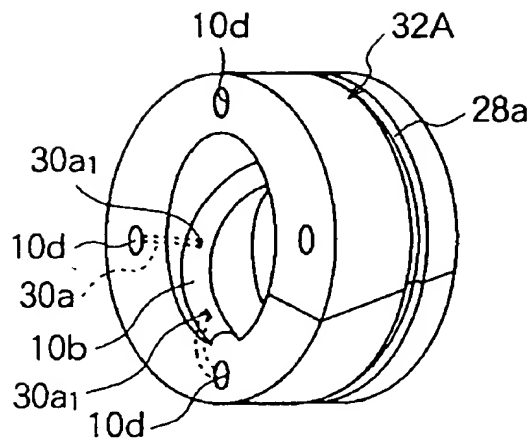
【図14】 Fig 14



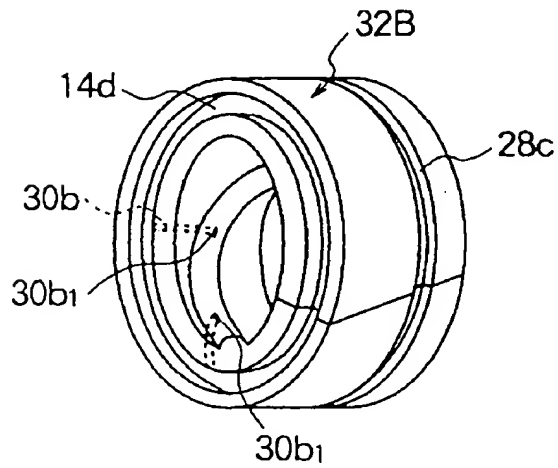
【図15】 Fig 15



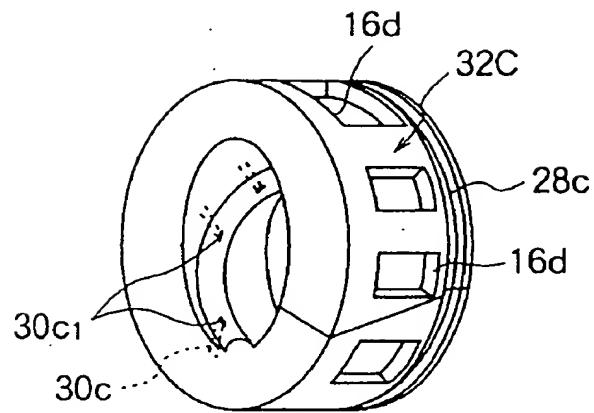
【図16】 Fig 16



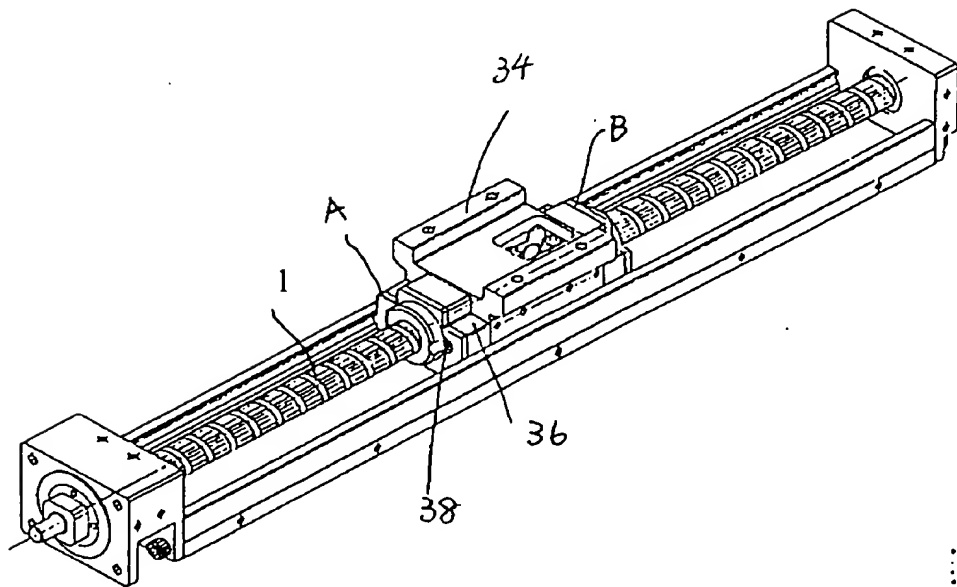
【図17】 Fig 17



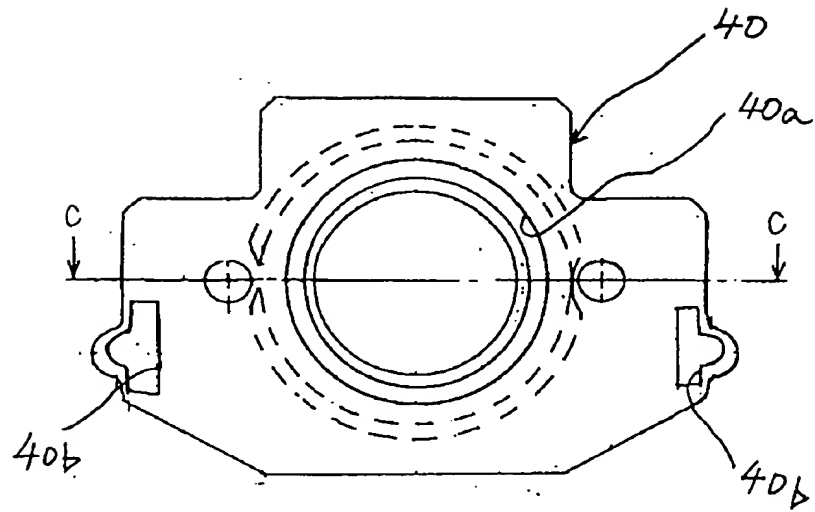
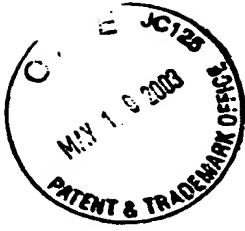
【図18】 Fig 18



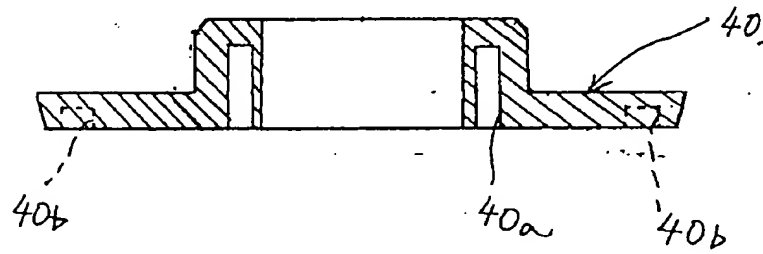
【図19】 Fig 19



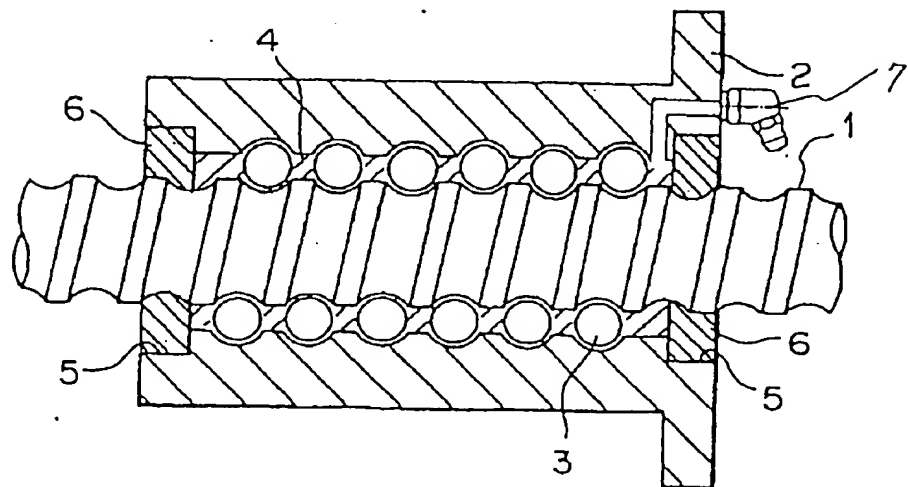
【図20】 Fig 20



【図21】 Fig 21



【図22】 Fig 22



**This Page is Inserted by IFW Indexing and Scanning
Operations and is not part of the Official Record**

BEST AVAILABLE IMAGES

Defective images within this document are accurate representations of the original documents submitted by the applicant.

Defects in the images include but are not limited to the items checked:

- ☐ **BLACK BORDERS**
- ☐ **IMAGE CUT OFF AT TOP, BOTTOM OR SIDES**
- ☐ **FADED TEXT OR DRAWING**
- ☐ **BLURRED OR ILLEGIBLE TEXT OR DRAWING**
- ☐ **SKEWED/SLANTED IMAGES**
- ☐ **COLOR OR BLACK AND WHITE PHOTOGRAPHS**
- ☐ **GRAY SCALE DOCUMENTS**
- ☐ **LINES OR MARKS ON ORIGINAL DOCUMENT**
- ☒ **REFERENCE(S) OR EXHIBIT(S) SUBMITTED ARE POOR QUALITY**
- ☐ **OTHER:** _____

IMAGES ARE BEST AVAILABLE COPY.

As rescanning these documents will not correct the image problems checked, please do not report these problems to the IFW Image Problem Mailbox.